The Advantages of Selenium in Surge Supression Circuits

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Selenium, when used in surge suppression devices in a "hybrid" design, combined with Metal Oxide Varistors (MOVs) have four distinct performance advantages over devices which contain only MOVs. The operating characteristics of Selenium, combined with MOVs makes for unsurpassed performance in minimizing or eliminating damage from high energy transients.

The advantages are:

Table A

MOV vs. Selenium "Hybrid"

Surge Current Rating	Model # Selenium Based Unit	Number of Impulses/ Mode	Model #, MOV OnlyUnit	Number of Impulses/ Mode	Percent Diff.
300,000 amps	SEL 300	>15,000	TG 300	>7,500	200%
250,000 Amps	SEL 250	>14,000	TG 250	>7,000	200%
200,000 Amps	SEL 200	>13,000	TG 200	>6,500	200%
150,000 Amps	SEL 150	>12,000	TG 150	>5,500	218%
100,000 Amps	SEL 100	>11,000	TG 100	>4,500	244%

A Non-Sacrificial Technology

Every MOV carries a rating of "so many" amps. The rating is based on the size of the MOV: 6,500 or 10,000 amps for a 20mm MOV, 30,000 amps for a 32mm MOV, 40,000 or 80,000 amps for a 40mm MOV, and so on. When exposed to an impulse in excess of the surge current rating, the MOV will, in most cases fail. Additionally, a combination of a given number of lower level impulses will, at some point, cause the MOV to fail. MOVs by design, are sacrificial components. Selenium by nature, is non-sacrificial. When used in a "hybrid" system, even if the MOVs have failed, the Selenium continues to provide protection. This is particularly important in the case of a lightning strike which actually consists of 6-12 strokes of diminishing amplitude. Even if the first stroke or first few strokes, takes out the MOVs, the critical load will continue to be protected by the Selenium. **Even if the surge current handling capacity of the Selenium is exceeded, the Selenium plates "self heal" and almost instantaneously return to operational status.**

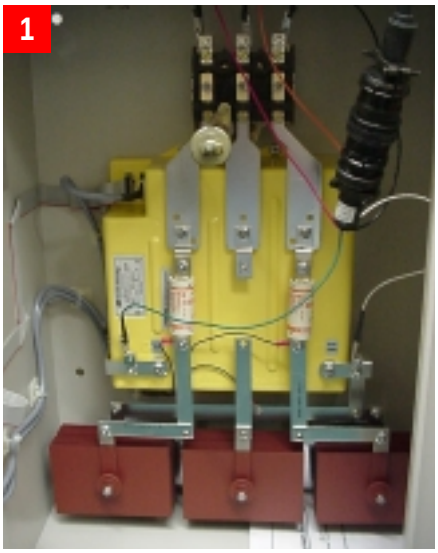
Longevity

One of the primary measurements of performance for TVSS units is the number of impulses the unit can withstand without failure. The standards used for comparison are ANSI/IEEE C62.41, category "C.3" which uses a 20,000 volt, 10,000 amp impulse and ANSI/IEEE C62.45 which defines the parameters for the testing, such as time interval between impulses, to determine the number of impulses the device can successfully withstand. ANSI/IEEE C62.41 defines the waveform and other characteristics.

Manufacturers publish the number of impulses their units can withstand without failure per these two standards. Using these standards, a Selenium based "hybrid" system increases the number of 10,000 amp impulses a given unit can withstand by 200% - 244%. **As a minimum, in the field, a Selenium based system will last twice as long as a MOV only system.** Please review table "A" above for an exact comparison between MOV only and "hybrid" Selenium based units.

Clamping Voltage

Photograph 1 (above right) shows test probes connected to the three phases of a "hybrid" TVSS unit containing Selenium. This unit is a 120/208 volt, three phase, wye system. Note that phase "B" has had the fuse connecting the Selenium removed, while the fuses for phases "A" and "C" are intact. When a 1600 volt impulse from a surge generator is placed on phase "A", the clamping voltage is measured at 188 volts. Likewise, on phase "C" the clamping voltage is measured at 187 volts. However, phase "B", the phase with only MOVs had



a clamping voltage of 267 volts. The actual clamping voltages are shown in photographs 2, 3, & 4 (page 2). **When you consider that you do not want to begin to clamp an impulse at less than 120% above nominal, (144 volts), and that a typical 120 volt rated TVSS' unit utilizes 150 volt MOVs, a clamping voltage of 187 volts is extraordinary. The difference in clamping voltage between the technologies is 80 volts, or an improvement of 316%, over an MOV only system.**

Swell Withstandabilty

MOVs can fail by one of two methods, overexposure or heat. As previously mentioned, the addition of Selenium greatly

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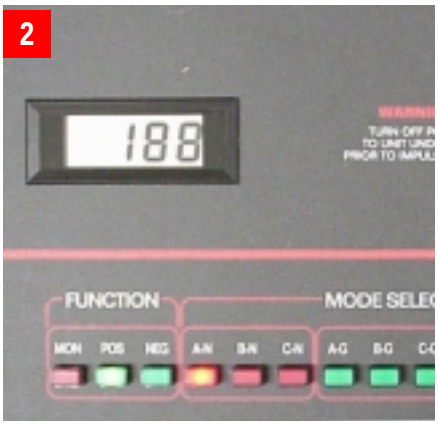

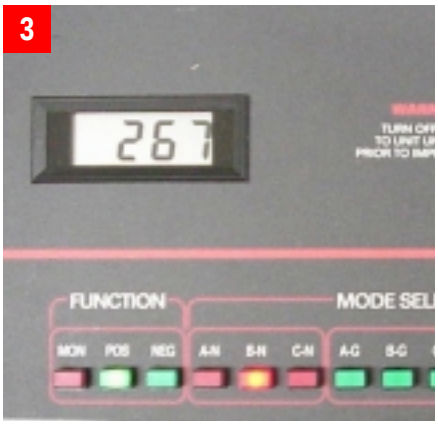

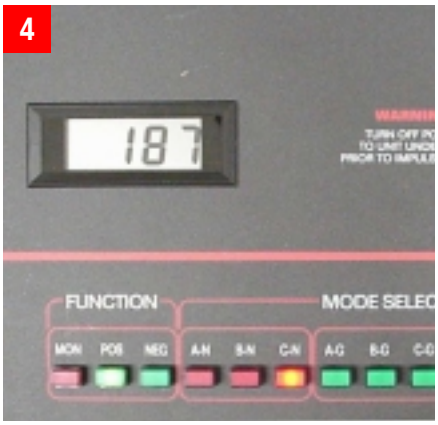

improves the ability of MOVs to handle a single large overexposure, as well as the number of lower level overexposures. Failure due to overheating is caused by a "swell" condition. A "swell" is a multi-cycle overvoltage. This condition causes the MOV to repeatedly "fire", building up heat in the MOV until the overheating causes the MOV to fail. Making the likelihood of this scenario to occur more common are the recent changes UL made to their 1449 standard. In the past, TVSS manufacturers potted their MOVs. This potting material also served as a heat sink which drew the heat away from the MOVs. The new UL 1449 standard called for an overvoltage test. TVSS manufacturers found that in almost every case, their potting material melted, and in some cases actually flowed out of their TVSS units, causing them to fail testing. To alleviate the problem, TVSS manufacturers took to packing their MOVs in sand. Every change has an engineering trade-off. While the sand allows TVSS units to pass the UL 1449 testing, sand serves as an excellent insulating material. When an MOV in a TVSS unit of current design experiences a "swell" condition, the sand keeps the MOV from dissipating the heat and causes the MOV to fail faster than in the older designs with potting material. Please review table "B" taken from the guide specification for a Selenium based "hybrid" product. With a line impedance of .7 ohms, a Selenium based unit can withstand a "swell" condition measuring 200% over nominal voltage for over >3,600 cycles (one minute). You will never see a 200% overvoltage for more than a few seconds in the field. Compare this performance against 5-10 cycles, which is the approximate number of cycles an MOV only product can withstand in the same situation.

Selenium based products carry a price premium of 20-40%, depending on the surge current rating (the higher the rating, the smaller the difference). When you consider that Selenium based units last twice as long, provide better protection by way of a lower clamping voltage and that they continue to provide protection, even if the MOVs have sacrificed themselves, 20-40% is a small premium. If you can justify $1,000, Selenium is the way to go. It is important to note that only Current Technology offers a Selenium based product. If you are not willing to hold the performance levels offered by Selenium, you will definitely not get a Selenium based product.

Another important point to consider is to look at the warranties offered by the TVSS manufacturers. You will note that most TVSS manufacturers do not cover "overexposures", and their warranties are for five years. When you compare the differences between Selenium "hybrid" units and MOV only units you will note that three of the four differences (non-sacrificial technology, longevity and swell withstandabilty) are related to product life and reducing the probability of failure due to overexposure. Current Technology covers unlimited overexposures for ten years under their warranty for Selenium based products. **If an MOV only product experiences an overexposure during the warranty period and the client has to purchase a replacement, a Selenium unit purchased upfront would have saved the client at least 33%.** The question to ask is: "Am I willing to accept a unit where the manufacturer does not cover the most likely cause of failure.?" Keep in mind that when a unit fails and the customer has to purchase a replacement they usually pay the TVSS manufacturer list price. You are, in effect, rewarding a manufacturer for making a substandard product.

Table B

Excessive MCOV Withstand

% Overvolatge	160%	170%	180%	190%	195%	200%
Line impedance of power system=0.1 ohms						
# of cycles	>3600	200	40	8	5	4
Line impedance of power system=0.3 ohms						
# of cycles	>3600	>3600	700	125	80	30
Line impedance of power system=0.7 ohms						
# of cycles	>3600	>3600	>3600	>3600	>3600	>3600